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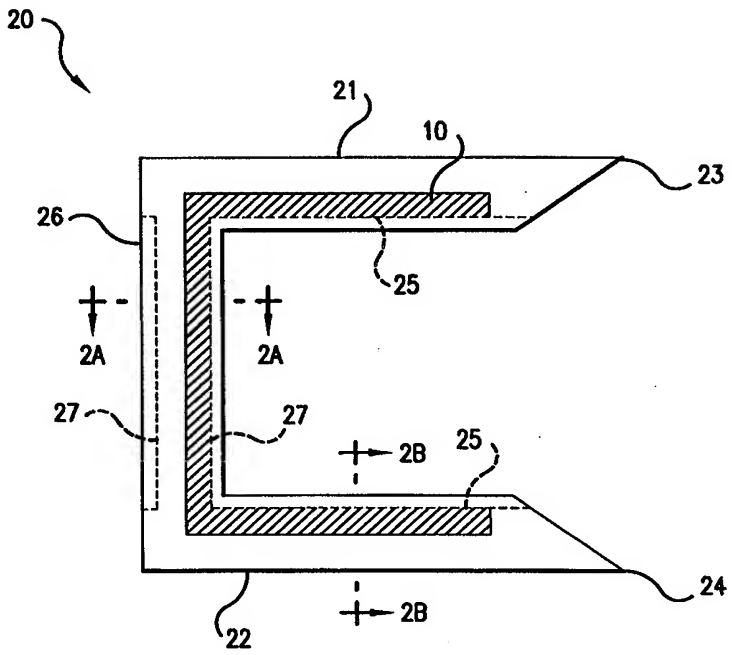

(57) Abstract

Clips having pseudoelastic properties at body temperature are used to cause hemostasis of blood vessels located along the gastrointestinal tract. Methods for causing the hemostasis of blood vessels and ulcer beds using the clips of the present invention are also disclosed.

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HEMOSTATIC CLIPS

Field of the Invention

The present invention relates to hemostatic clips, and more specifically, to pseudoelastic nitinol clips which are used to cause hemostasis of blood vessels located along the gastrointestinal tract.

Background of the Invention

Gastrointestinal bleeding is a somewhat common and serious condition that can be fatal if left untreated. This problem has prompted the development of a number of endoscopic therapeutic approaches to achieve hemostasis, such as the injection of sclerosing agents and contact thermo-coagulation techniques. Although such approaches can be effective, bleeding often continues for many patients and corrective surgery therefore becomes necessary. Because surgery is an invasive technique that can be associated with many undesirable side effects, there exists the need for highly effective, less invasive procedures.

Mechanical hemostatic devices have been used in various parts of the body, including gastrointestinal applications. Such devices are typically in the form of clamps, clips, staples, sutures, etc. which are able to apply sufficient constrictive forces to blood vessels so as to limit or interrupt blood flow. One of the problems associated with conventional hemostatic devices, however, is that they can only be delivered using rigid-shafted instruments via incision or trocar cannula. Moreover, none of the conventional endoscopic hemostatic

devices are strong enough to cause permanent hemostasis.

In order to avoid the problems associated with conventional hemostatic devices, the use of shape memory alloys has been proposed. For example, U.S. Patent No. 4,485,816, hereby incorporated by reference, discloses the use of a shape memory surgical staple for use in holding the edges of a wound together while it heals. Similarly, U.S. Patent No. 5,002,563, hereby incorporated by reference, discloses the use of shape memory sutures.

Shape memory alloys (SMA's) have the ability to "remember" specific shapes which corresponds to particular metallurgical phases. If deformed, SMA's can be heated or cooled to invoke a phase transformation, which in turn, causes a transformation in shape. Shape memory alloys are characterized by a transition temperature or transition temperature range, above which the predominant metallurgical phase is termed austenite and below which the predominant phase is termed martensite. The transformation temperatures of SMA's are commonly discussed with reference to M_s and M_f, the martensitic start and finish temperatures, respectively, and A_s and A_f, the austenitic start and finish temperatures, respectively. The transformation between these phases is reversible such that when alloys are deformed into some first configuration while in the austenitic state, cooled into a martensitic state, deformed into a second configuration, and then re-heated to the austenitic state, the alloy will revert back to the first configuration by virtue of the martensite-to-austenite phase transformation.

PCT Publication No. WO 96/16603, hereby incorporated by reference, specifically discloses the use of shape memory materials to address the problem of gastrointestinal bleeding. In this reference, a hemostatic staple is employed to affect hemostasis of an actively bleeding peptic ulcer. The staple makes use of

the thermally-induced martensite-to-austenite transformation in shape memory nickel-titanium alloys ("nitinol"), thus requiring the application or removal of heat to the staple for deployment. One of the problems with this and similar SMA devices is that the change in temperature necessary to induce the required shape change can be procedurally difficult, and more importantly, can put the nearby tissue and surgical instrumentation at risk. In addition, it can be difficult to manufacture SMA's with the precise transformation temperatures necessary for surgical applications. It is therefore necessary to carefully monitor the temperature of such devices during shipping and storage so as to avoid phase transformations during this time. Moreover, the thermally-induced phase change may not produce forces adequate to hemostatically close vessels or compress tissue.

The use of nitinol alloys having the ability to form stress-induced martensite as opposed to thermally-induced martensite has been used in medical devices so as to avoid the potential problems of SMA devices. In such alloys, the reversible transformation between martensite and austenite occurs by the application and removal of stress rather than heat. Such alloys are characterized by an M_d temperature, which is greater than A_s and represents the maximum temperature at which stress-induced martensite can form. By deforming these alloys at a temperature between A_s and M_d, the alloy transforms from its austenitic phase to a stress-induced martensitic phase. Upon release of the stress within this temperature range, the alloy reverts back to its austenitic phase and unstressed configuration. The property of nitinol which allows it to be deformed in its austenitic state so to cause a transformation to stress-induced martensite that is transformed back to austenite by the release of stress is often termed "pseudoelasticity." Strains of 8% or more are obtained in

pseudoelastic nitinol, thus making this material useful for a wide range of applications where a large amount of recoverable deformation is required.

U.S. Patent No. 4,665,906, incorporated herein by reference, describes some medical devices which make use of pseudoelastic nitinol. In such devices, austenitic nitinol is deformed to form stress-induced martensite and held in its deformed configuration and martensitic state by a restraining member. In this condition, the device is introduced into the body, where it is removed from the restraining member to return to its austenitic state and configuration.

Summary of the Invention

The present invention is directed to hemostatic clips which exhibit pseudoelastic properties at body temperature. The clips of the present invention are able to compress tissue to cause the hemostasis of bleeding blood vessels, particularly gastrointestinal bleeders. In one embodiment of the present invention, the clips have a "U"-shaped configuration when in an undeformed state. In a second embodiment of the present invention, the clips have a circular-shaped configuration when in an undeformed state. The present invention includes methods and systems for causing the hemostasis of blood vessels and ulcer beds located along the gastrointestinal tract using hemostatic clips.

One advantage of the present invention is that it provides a reliable, definitive treatment for the problem of gastrointestinal bleeding.

Another advantage of the present invention is that it can be delivered via natural body orifices for the control of gastrointestinal bleeding.

Another advantage of the present invention is that it provides hemostatic clips which are deployed without the application or removal of heat.

Yet another advantage of the present invention is

that it provides hemostatic clips with sufficient strength to produce permanent hemostasis when deployed.

Another advantage of the present invention is that it provides hemostatic clips which are particularly designed for application to gastrointestinal bleeders.

Brief Description of the Drawings

Figs. 1A and 1B are plan views of a U-shaped hemostatic clip in a first and second configuration, respectively, in accordance with the present invention.

Fig. 2 includes plan and cross-sectional views of a hypotube of the present invention.

Figs. 3-5 illustrate a method of deploying the hemostatic U-shaped clips of the present invention.

Fig. 6 is a plan view showing an ulcer bed surrounded by hemostatic clips, in accordance with the present invention.

Figs. 7A and 7B are plan and end views, respectively, of a delivery device used to deploy the U-shaped hemostatic clips of the present invention.

Fig. 7B is a plan view of a delivery device deploying the hemostatic clips of the present invention adjacent an ulcer bed.

Figs. 8A and 8B are plan views of circular hemostatic clips of the present invention.

Fig. 9 is a plan view of a hypodermic needle of the present invention.

Fig. 10 is a plan view of a delivery device used to deploy the circular hemostatic clips of the present invention.

Figs. 11A-11D illustrate a method of deploying the hemostatic circular clips of the present invention.

Detailed Description

The present invention is designed to address the problems encountered in conventional methods used to ligate blood vessels. More particularly, the present

invention is adapted to restrict blood flow which results in gastrointestinal bleeding.

The present invention includes hemostatic clips which make use of pseudoelastic properties found in materials such as nitinol. Using these properties, the clips of the present invention are shaped into a first configuration that is useful for ligating blood vessels, deformed to a second configuration to facilitate placement to a desired location within the body, and released from its deformed configuration to allow a spontaneous reversion towards the first configuration.

The pseudoelastic material used to make the hemostatic clips of the present invention is characterized by an A_s temperature less than body temperature and an M_d temperature greater than body temperature. A clip in accordance with the present invention is thus provided with a first configuration in its austenitic state, which is deformed to a second configuration to facilitate the placement of the clip around or adjacent to a bleeding blood vessel. The deformation of the clip from its first configuration to its second configuration results in the formation of stress-induced martensite. The clip is held in its second configuration until positioned to a target location along the gastrointestinal tract. When released from this second configuration, the clip is urged toward its austenitic state and corresponding first configuration because A_s is less than body temperature and austenite is therefore the stable metallurgical phase. In this way, the clip applies sufficient constrictive forces to the bleeding blood vessel to cause hemostasis thereof.

The hemostatic clips of the present invention are of any suitable configuration. In a first embodiment of the present invention as shown in Fig. 1, however, hemostatic clip 10 is in the form of a U-shaped wire having first 11 and second 12 prongs, and rear member 13. The diameter

or width of rear member is less than that of either of the first 11 or second 12 prongs. The first configuration of clip 10 as shown in Fig. 1A represents the shape of clip 10 when in its substantially austenitic state. In this configuration, the distance between said first 11 and second 12 prongs is about 5-10 millimeters, preferably about 7 millimeters. This dimensional range is specifically designed to address the problem of gastrointestinal bleeders. The cross-section of clip 10 is preferably circular, although other cross-sectional shapes such as rectangular can be used.

To facilitate placement around or near a blood vessel, prongs 11 and 12 are urged in an outward direction to achieve a second configuration as shown in Fig. 1B. The distance between prongs 11 and 12 in this second configuration can be up to 15 millimeters or more. When deformed into the shape shown in Fig. 1B from the shape shown in Fig. 1A, U-shaped clip 10 undergoes at least a partial stress-induced transformation from austenite to martensite.

A device such as hypotube 20, as shown in Fig. 2, is used to hold U-shaped clip 10 in its second configuration while it is delivered to a target location along the gastrointestinal tract. Hypotube 20 is made of any suitable material, such as stainless steel.

Hypotube 20 includes first 21 and second 22 prongs having pointed ends 23 and 24, respectively. Along the length of the inner sides of first 21 and second 22 prongs are longitudinal slots 25. Along the length of both sides of rear member 26 are transverse slots 27. The width of slots 26 and 27 are wider than the width of rear member 13 of U-shaped clip 10, yet more narrow than first 11 and second 12 prongs of U-shaped clip 10. Such a configuration allows hypotube 20 to hold U-shaped clip 10 in its second configuration, while permitting the passage of U-shaped clip 10 through hypotube 20.

After placing clip 10 in hypotube 20, it is inserted

as part of a delivery device 30 into the gastrointestinal tract, preferably via a natural body orifice. Upon reaching a target location, the pointed ends 23 and 24 of hypotube 20 are used to penetrate the gastrointestinal wall 31 by advancing a first pusher bar 32 which is attached to hypotube 20, as shown in Fig. 3. Also shown in Fig. 3 is second pusher bar 33, which rests against, but is not attached to, clip 10. Second pusher bar 33 is inserted through transverse slots 27 of hypotube 20 to contact clip 10. The length of prongs 21 and 22 are sufficient to ensure that the blood vessel to be treated is positioned between the prongs 11 and 12 of clip 10, or is within about one centimeter of the ends of prongs 11 and 12 of clip 10. The rear member 26 of hypotube 20 remains outside of the gastrointestinal wall.

To deploy clip 10, hypotube 20 is withdrawn from the gastrointestinal wall 31 by retracting first pusher bar 32, as shown in Fig. 4. During the withdrawal of hypotube 20, second pusher bar 33 remains extended so to keep clip 10 at the target location. As clip 10 is released from hypotube 20, it is urged towards its austenitic configuration as shown in Fig. 4. When hypotube 20 is completely withdrawn from the gastrointestinal wall 31, the contact between second pusher bar 33 and clip 10 is broken as shown in Fig. 5.

The clips of the present invention are delivered by any suitable instrumentation, as is known in the art. For delivery of the clips via natural body orifices, which is the preferred method of delivery, it is usually necessary to deliver the clips with the aid of steerable endoscope to allow the physician installing the clips to visually examine the target location. "Endoscope" is intended to include similar instrumentation such as a gastroscope or duodenoscope.

In addition to causing the hemostasis of individual blood vessels, the present invention contemplates the use of hemostatic clips to cause the hemostasis of bleeding

ulcer beds. In order to achieve the hemostasis of an ulcer bed, it is desirable to substantially surround the ulcer bed 60 with hemostatic clips 62, as shown in Fig. 6. This is preferably achieved with two pairs of hemostatic clips 62, each pair being substantially parallel to each other yet orthogonal to the other pair. The hemostatic clips 62 are deployed into the gastrointestinal wall 61 in the configuration shown in Fig. 6 so to reduce the flow of blood to ulcer bed 60. Each of the clips 62 should be within about 5 mm, preferably about 2 mm, and most preferably about 1 mm from the edge of ulcer bed 60.

In order to achieve the configuration of clips shown in Fig. 6, it is necessary to manipulate the clip delivery device to properly orient the clips prior to insertion. This can be done with steerable endoscopes, as are known in the art, provided that the clips are deployed in regions of the gastrointestinal tract that are wide enough to permit such manipulation (e.g., the stomach or lower bowel). In narrow regions of the gastrointestinal tract (e.g., the duodenum), however, it may be necessary to use a delivery device in which the clips are pre-loaded in the proper orientation. An example of such a device is shown in Figs. 7A-7C. As shown in Fig. 7A, delivery device 70 comprises an endoscope 71 having a sheath 72 ending in a collar 73 that houses the hemostatic clips. As shown in Fig. 7B, the clips 10 are oriented for the deployment configuration as shown in Fig. 6. As is known in the art, endoscope 71 includes optics 74 and at least one light 75. Sheath 72 is used to house any wires, instrumentation, etc. necessary to deploy clips 10 from collar 73. In addition, sheath 72 is optionally slidable about endoscope 71 to permit rotation of collar 73 and the corresponding axial positioning of clips 10. Although U-shaped clips 10 are shown in Fig. 7B, collar 73 is easily adapted for the deployment of hemostatic

clips having a circular or other configuration. To deploy clips 10, endoscope 71 is oriented so that the surface of collar 73 is adjacent the gastrointestinal wall 61 as shown in Fig. 7C. Clips 10 are thereafter inserted into the gastrointestinal wall 61 so as to substantially surround ulcer bed 60 in an arrangement as shown in Fig. 6.

In another embodiment of the present invention, the nitinol hemostatic clip of the present invention is in a substantially circular configuration when it is in a substantially austenitic state, as shown in Fig. 8. Circular clip 80 has a diameter of about 5-10 millimeters, and preferably about 7 millimeters when in its austenitic configuration. This dimensional range is specifically designed to address the problem of gastrointestinal bleeders. Circular clip 80 can have interlocking or adjoining ends 81, 82, as shown in Fig. 8A, or overlapping ends as shown in Fig. 8B.

To facilitate placement around or near a blood vessel, the ends of circular clip 80 are urged away from each other so that clip 80 achieves some second configuration that permits clip deployment. This second configuration typically has a straightened or arc shape. When deformed into this second configuration, circular clip 80 undergoes at least a partial stress-induced transformation from austenite to martensite.

A device such as hypodermic needle 90, as shown in Fig. 9, is used to hold circular clip 80 in its second configuration while it is delivered to a target location along the gastrointestinal tract. Hypodermic needle has an arc configuration and includes pointed end 91, base 92 and pusher bar 93. Hypodermic needle 90 is made of any suitable material, although stainless steel is preferred.

Circular clip 80 is delivered to a target location along the gastrointestinal tract by any suitable instrumentation, as is known in the art. Circular clip 80 is preferably delivered with the delivery device shown

in Fig. 10. Delivery device 100 includes a duodenoscope 101 having side-mounted optics 102, at least one side-mounted light 103 and grasper 104. Sheath 105, ending in collar 106, covers only part of the circumference of duodenoscope 101 so as not to cover the optics 102, light 103 or grasper 104.

Delivery device 100 is used to deliver circular clip 80 by the method shown in Figs. 11A-11D. As shown in Fig. 11A, the delivery device 100 is delivered to a target location along the gastrointestinal tract. Grasper 104 is used to grasp the gastrointestinal wall 31 and pull it towards the duodenoscope 101. As shown in Fig. 11B, hypodermic needle 90 penetrates the pulled portion of the gastrointestinal wall and is advanced to a desired location while housing circular clip 80 and pusher bar 93. Circular clip 80 is released by retracting hypodermic needle 90 from the pulled gastrointestinal wall while holding the clip 80 with pusher bar 93. After hypodermic needle 90 is fully retracted from the pulled gastrointestinal wall, pusher bar 93 is likewise retracted into collar 106. The pulled gastrointestinal wall is then released and clip 80 resumes its austenitic circular configuration as shown in Fig. 11D.

The mechanism by which hypodermic needle 90 and/or push bar 93 is advanced from or retracted into collar 106 is any suitable mechanism as is known in the art. For example, this mechanism can include a pulley and cable mechanism, a fluid pressure and piston mechanism, or a gear driven (e.g., rack and pinion) mechanism. A pulley and cable system, however, is preferred as it is the most simple of these systems.

The present invention provides a reliable, definitive treatment for the problem of gastrointestinal bleeding. Moreover, the present invention provides hemostatic clips that are deployable via natural body

orifices and without the manipulation of temperature. When deployed in accordance with the present invention, the clips provide sufficient strength to produce permanent hemostasis.

It will be obvious to those skilled in the art, having regard to this disclosure, that other variations on this invention beyond those specifically exemplified here may be made. Such variations are, however, to be considered as coming within the scope of this invention as limited solely by the following claims.

Claims:

1. A hemostatic device, comprising:

a clip exhibiting pseudoelastic behavior at body temperature;

wherein said clip is used to cause the hemostasis of a blood vessel located along the gastrointestinal tract.

2. The hemostatic device of claim 1, wherein said clip comprises nitinol characterized by an A_s temperature less than body temperature and an M_d temperature greater than body temperature.

3. The hemostatic device of claim 2, wherein said clip has a substantially U-shape configuration when said nitinol in a substantially austenitic phase, said U-shape configuration comprising a first prong and a second prong.

4. The hemostatic device of claim 3, wherein the distance between said first and second prongs is about 5-10 millimeters when said nitinol is in a substantially austenitic state.

5. The hemostatic device of claim 2, wherein said clip has a substantially circular configuration when said nitinol is in a substantially austenitic state.

6. The hemostatic device of claim 5, wherein said clip has an inner diameter of about 5-10 millimeters when said nitinol is in a substantially austenitic state.

7. A method for causing the hemostasis of a blood vessel located along the gastrointestinal tract,

said method comprising the steps of:

providing a clip exhibiting pseudoelastic behavior at body temperature;

deforming said clip from a first configuration to a second configuration;

delivering said clip to a target location along the gastrointestinal tract, said delivering occurring with the use of a delivery device which holds said clip in said second configuration; and

releasing said clip from said delivery device such that said clip is urged toward said first configuration, said clip thereby applying sufficient constrictive forces to said blood vessel to cause hemostasis thereof.

8. The method of claim 7, wherein said clip comprises nitinol characterized by an A_s temperature less than body temperature and an M_d temperature greater than body temperature.

9. The method of claim 8, wherein said nitinol is in a substantially austenitic state when in said first configuration and said nitinol is in a substantially stress-induced martensitic state when in said second configuration.

10. The method of claim 7, wherein said step of delivering occurs via a natural body orifice.

11. The method of claim 7, wherein said target location is within about 1 centimeter of the blood vessel.

12. The method of claim 7, wherein:

said first configuration of said clip is substantially U-shaped and comprises a first prong and a second prong;

said second configuration of said clip is substantially U-shaped and comprises a first prong and a second prong, said first and second prongs being further apart in said second configuration than in said first configuration; and

said delivery device comprises a hypotube for holding said clip in said second configuration during said delivering step, said hypotube having a U-shaped configuration comprising a first prong and a second prong, said first and second prongs of said hypotube having pointed ends.

13. The method of claim 12, further comprising the steps of:

penetrating the gastrointestinal wall with said pointed ends of said hypotube while said hypotube holds said clip;

advancing said hypotube to a desired location within the gastrointestinal wall; and

withdrawing said hypotube from the gastrointestinal wall while holding said clip at said desired location.

14. The method of claim 7, wherein:

said first configuration of said clip is substantially circular;

said delivery device comprises

an endoscope;

a collar mounted on said endoscope;

a hypodermic needle having an arc configuration and a pointed end, said hypodermic needle being housed in said collar; and

a tissue grasper extendable from said endoscope; and

said deforming step comprises the step of inserting said clip into said hypodermic needle such that said second configuration of said clip is an arc.

15. The method of claim 14, further comprising the steps of:

grasping the gastrointestinal wall with said tissue grasper;

pulling the gastrointestinal wall towards said endoscope with said tissue grasper; and

penetrating the pulled gastrointestinal wall with said hypodermic needle; and

advancing said hypodermic needle to a desired location within the pulled gastrointestinal wall.

16. The method of claim 15, wherein said releasing step comprises the step of retracting said hypodermic needle from the pulled gastrointestinal wall while holding said clip at said desired location.

17. A method for causing the hemostasis of an ulcer bed located along the gastrointestinal tract, said method comprising the steps of:

providing a plurality of clips, each of said clips exhibiting pseudoelastic behavior at body temperature;

deforming each of said clips from a first configuration to a second configuration;

delivering said plurality of clips to respective target locations along the gastrointestinal tract such that the ulcer bed is substantially surrounded by said clips, said delivering occurring with the use of a delivery device which holds each of said clips in said second configuration;

releasing each of said clips from said delivery device such that each of said clips is urged toward said first configuration.

18. The method of claim 17, wherein each of said clips is within about 5 millimeters of said ulcer bed.

19. The method of claim 18, wherein each of said clips is within about 1 millimeter of said ulcer bed.

20. The method of claim 17, wherein said delivery device comprises:

an endoscope; and

a collar on said endoscope, wherein said collar houses four clips such that a first pair of clips are parallel to each other and a second pair of clips are parallel to each other, said first pair of clips being orthogonal to said second pair of clips.

21. A system to achieve the hemostasis of a blood vessel located along the gastrointestinal tract, said system comprising:

a clip exhibiting pseudoelastic behavior at body temperature; and

a delivery device.

22. The system of claim 21, wherein:

said clip has a first substantially U-shape configuration when in a substantially austenitic state, said first substantially U-shape configuration comprising a first prong and a second prong; and

said delivery device comprises an endoscope and means for holding said clip in a second substantially U-shaped configuration comprising a first prong and a second prong, wherein the distance between said first and second prongs is greater in said second substantially U-shaped configuration than in said first substantially U-shaped configuration.

23. The system of claim 22, wherein:

said means for holding said clip in a second substantially U-shaped configuration comprises a hypotube having a U-shaped configuration comprising a first prong and a second prong, said first prong and said second prong of said hypotube having pointed ends.

24. The system of claim 23, wherein said hypotube is characterized by a longitudnal slot.

25. The system of claim 21, wherein:

said clip has a substantially circular configuration when in a substantially austenitic phase;

said delivery device comprises

an endoscope;

a collar mounted on said endoscope;

a hypodermic needle having an arc configuration and a pointed end, said hypodermic needle being housed in said collar; and

a tissue grasper extendable from said endoscope; and

said hypodermic needle holds said clip in an arc configuration during insertion into the gastrointestinal tract.

26. A system to achieve the hemostasis of an ulcer bed located along the gastrointestinal tract, said system comprising:

a plurality of clips exhibiting pseudoelastic behavior at body temperature; and

a delivery device.

27. The system of claim 26, wherein:

said system comprises four clips; and

said delivery device comprises

an endoscope; and

a collar on said endoscope, wherein said collar houses said clips such that a first pair of clips are parallel to each other and a second pair of clips are parallel to each other, said first pair of clips being orthogonal to said second pair of clips.

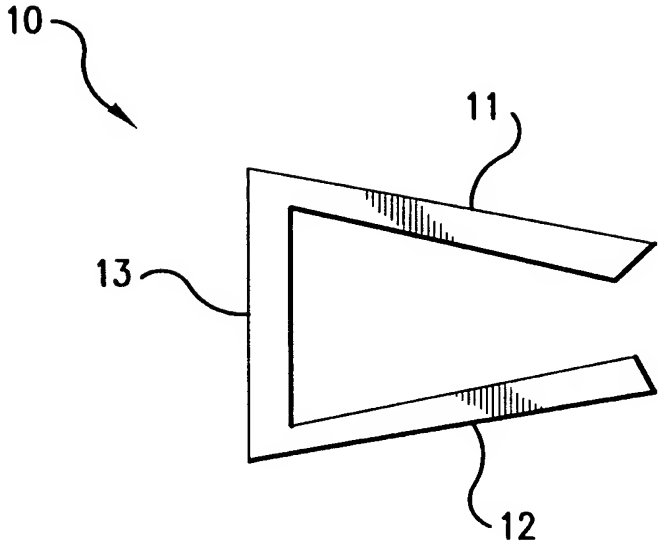

FIG.1A

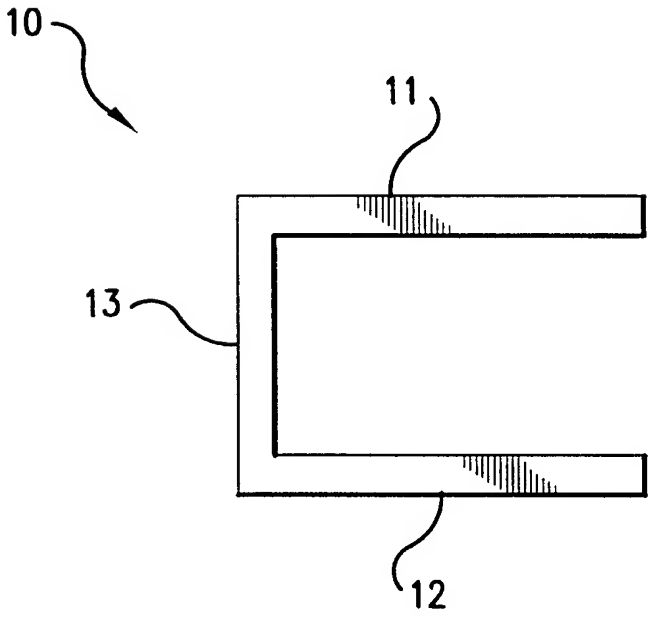

FIG.1B

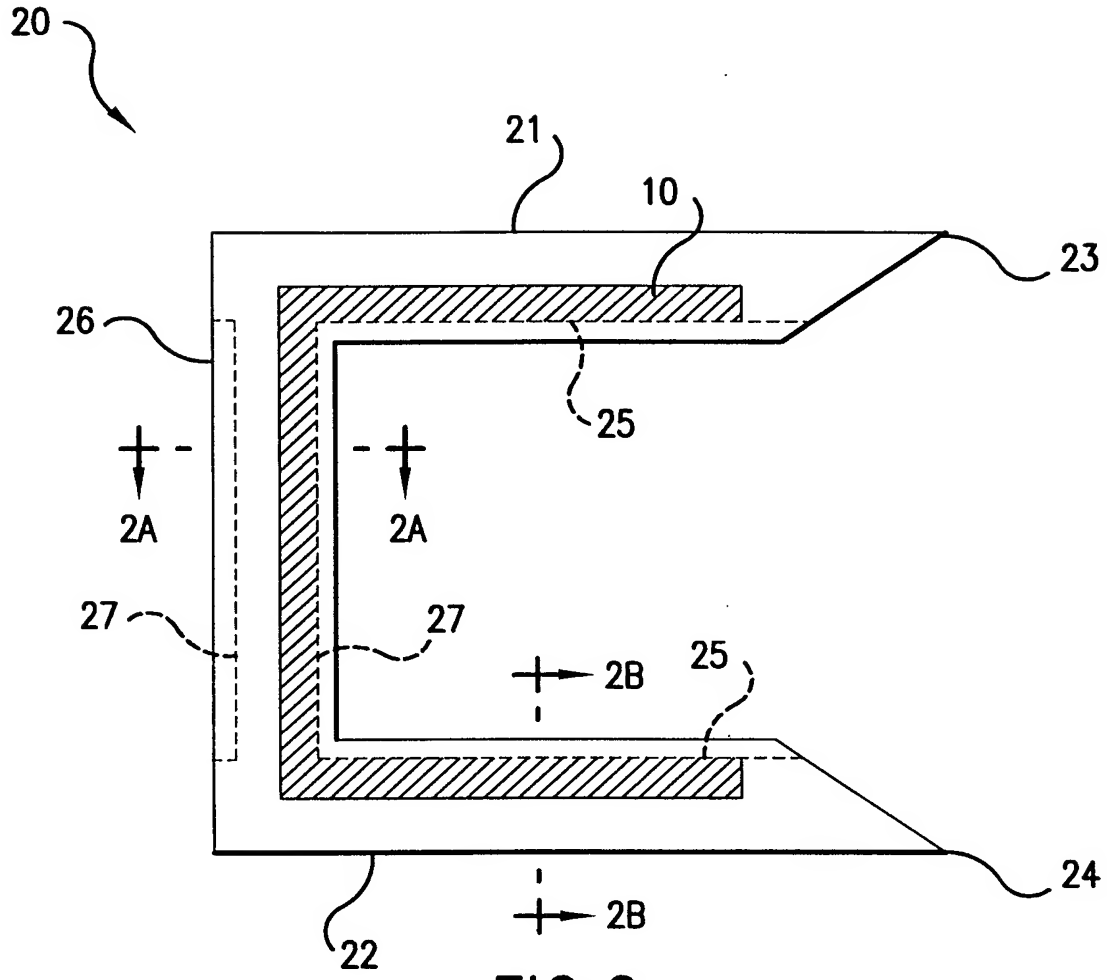

FIG.2

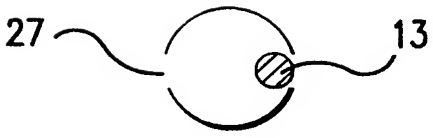

FIG.2A

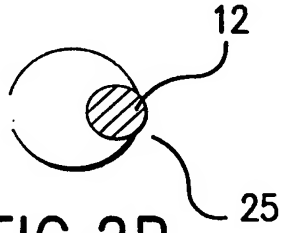

FIG.2B

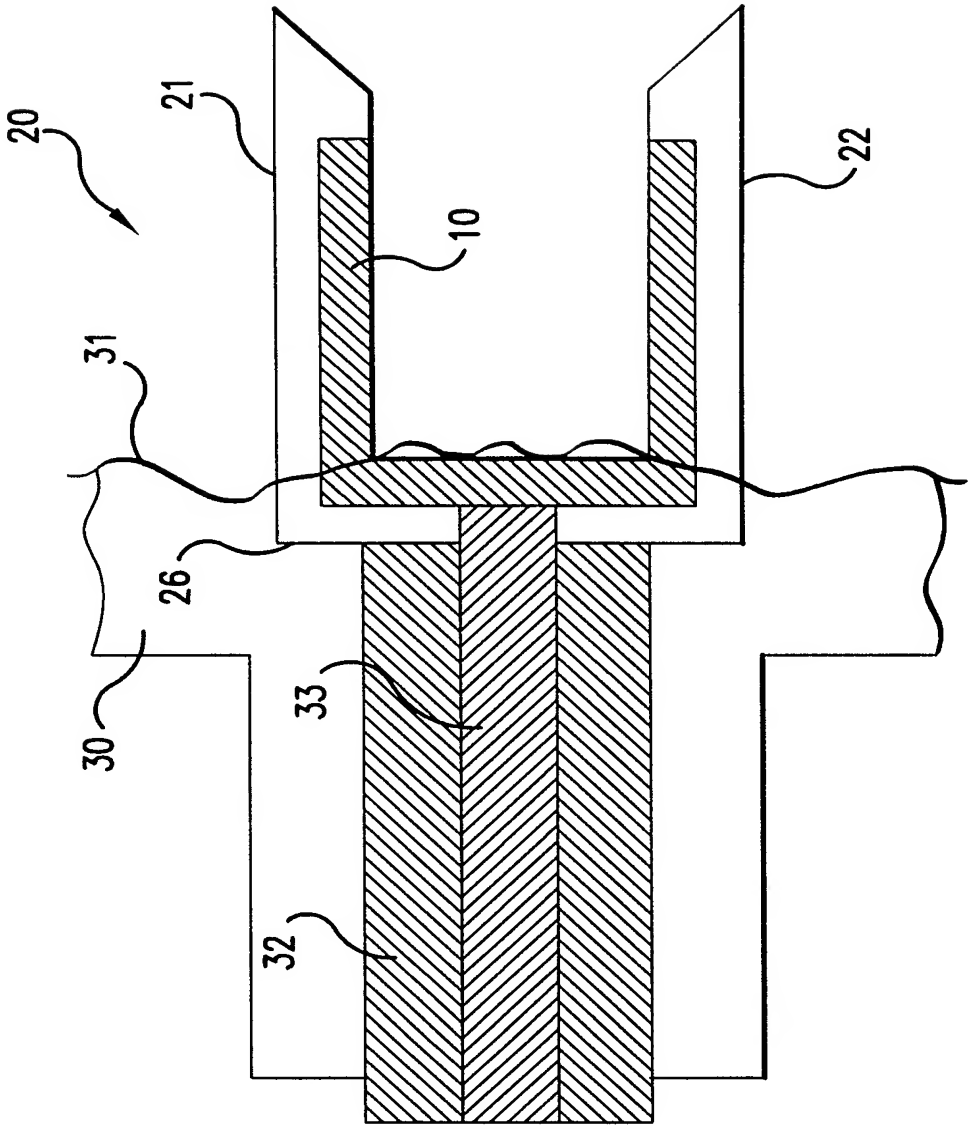

FIG.3

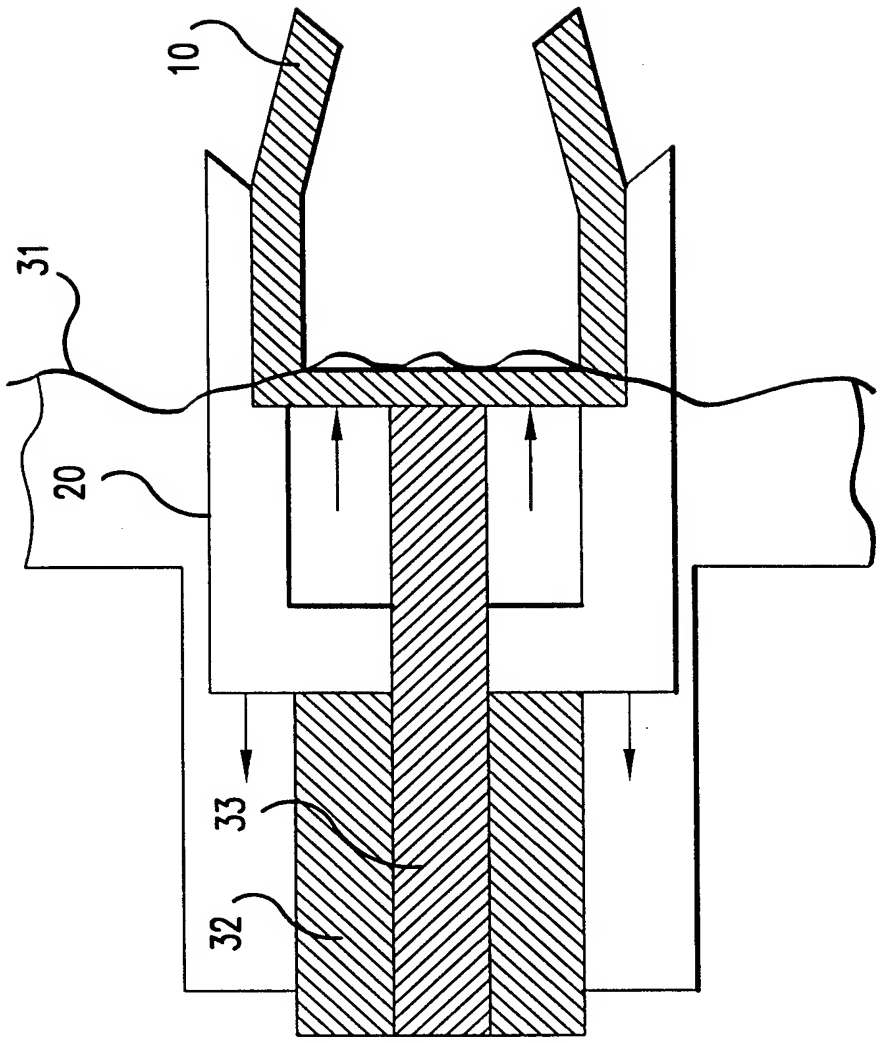

FIG.4

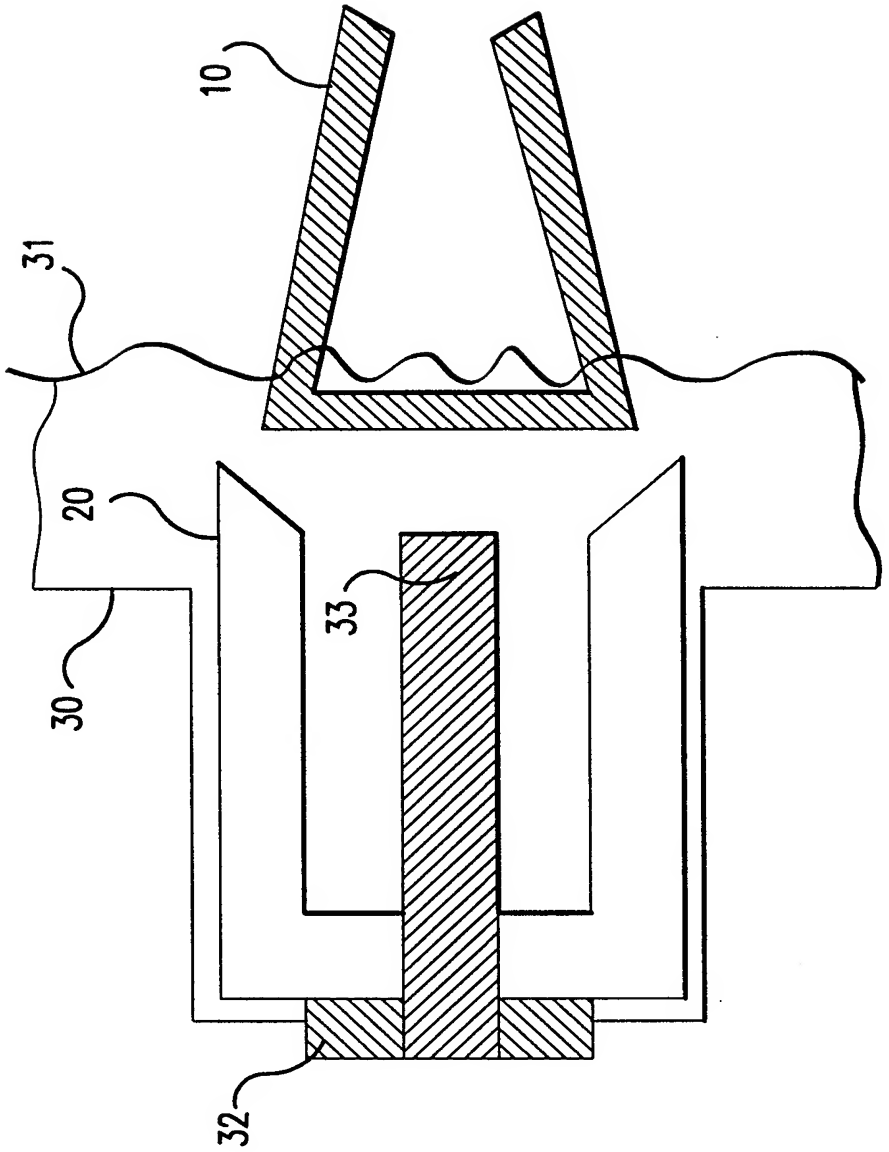

FIG.5

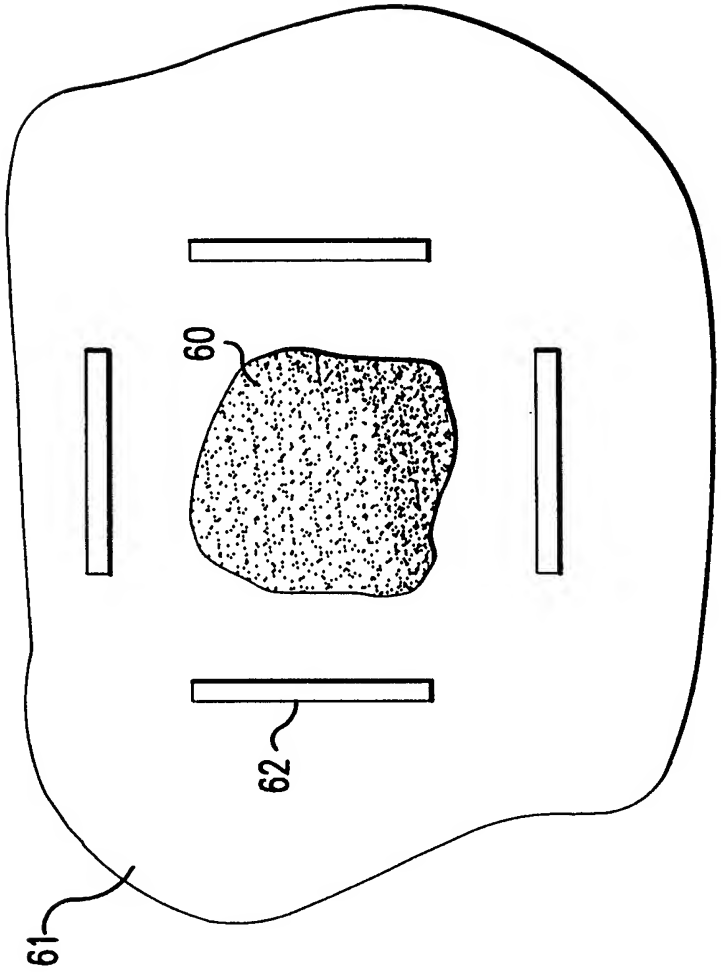

FIG.6

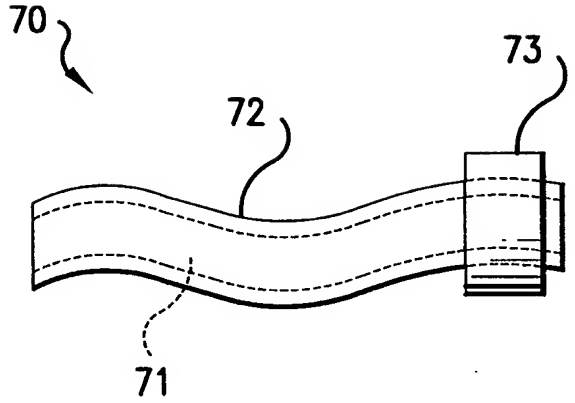

FIG.7A

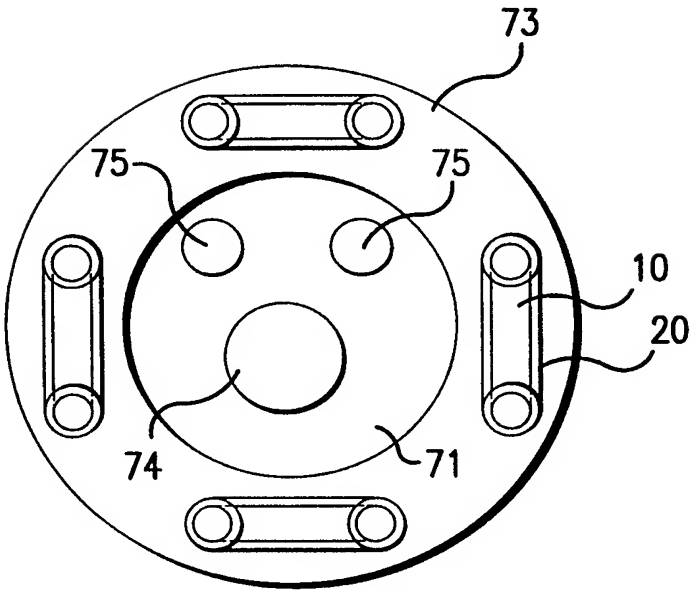

FIG.7B

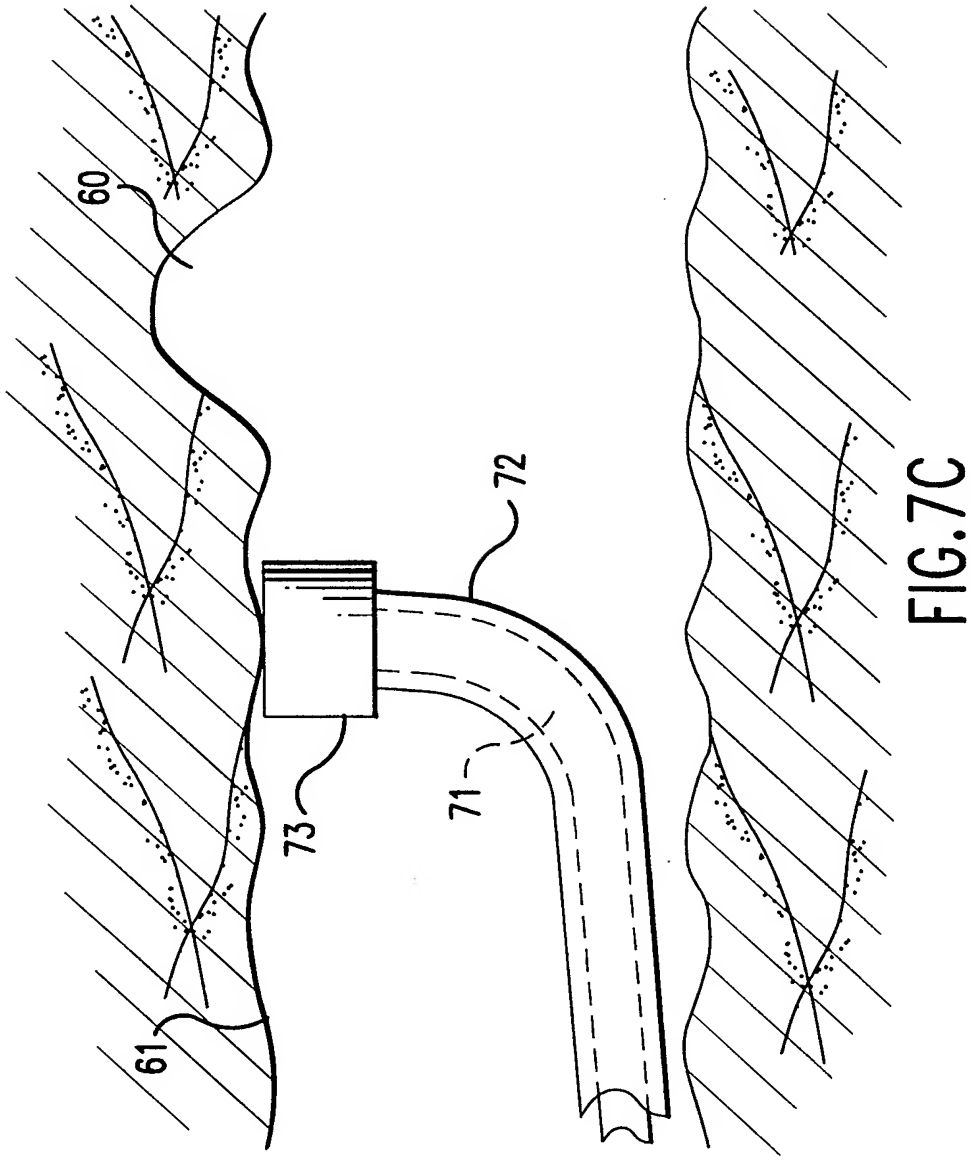

FIG.7C

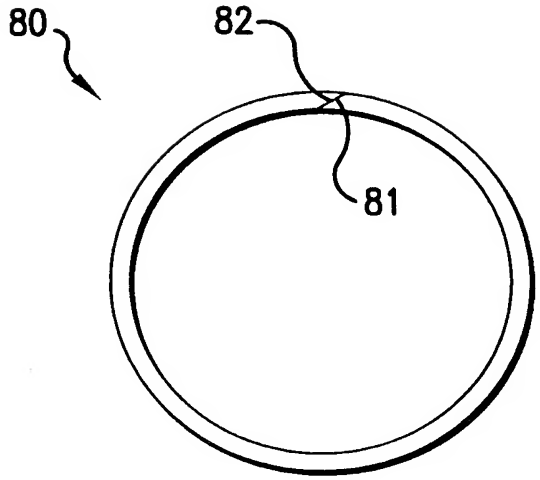

FIG.8A

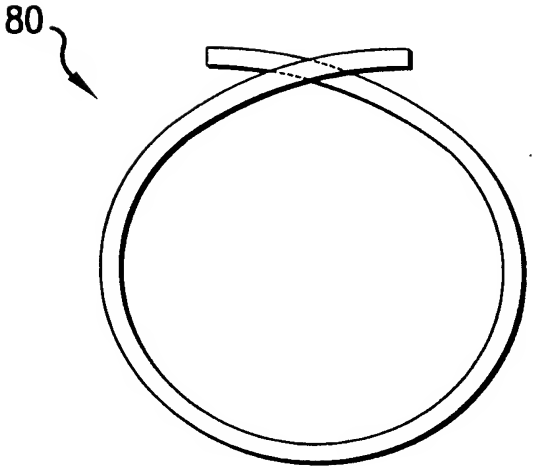

FIG.8B

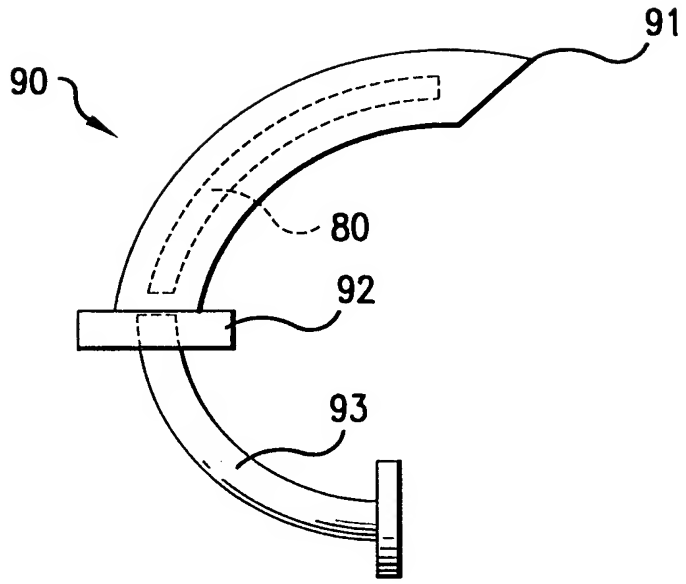

FIG.9

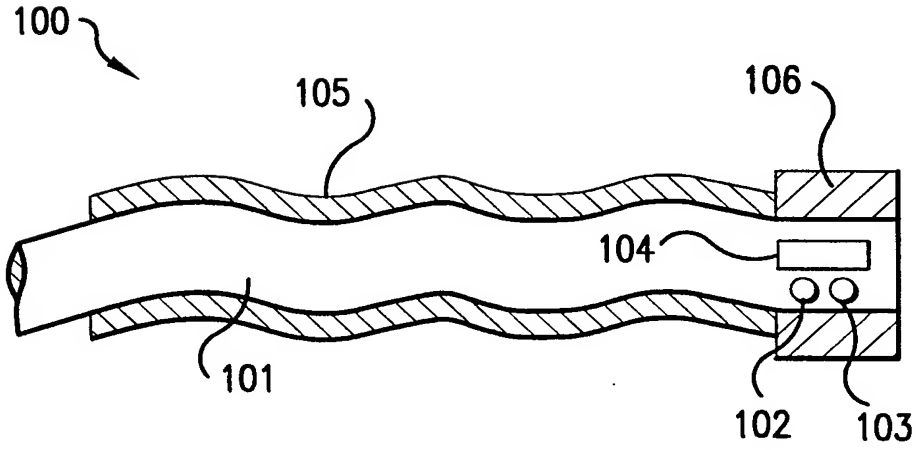

FIG.10

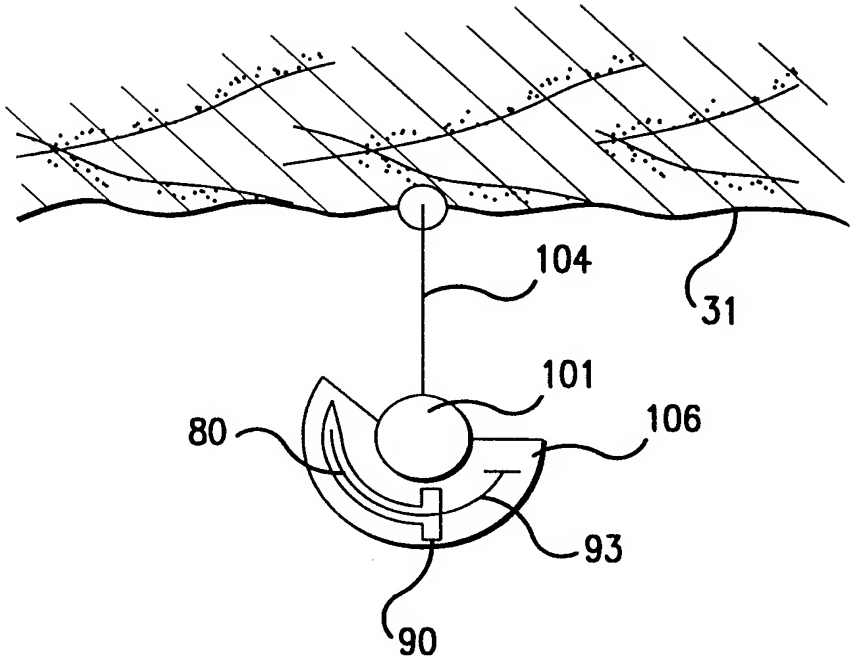

FIG.11A

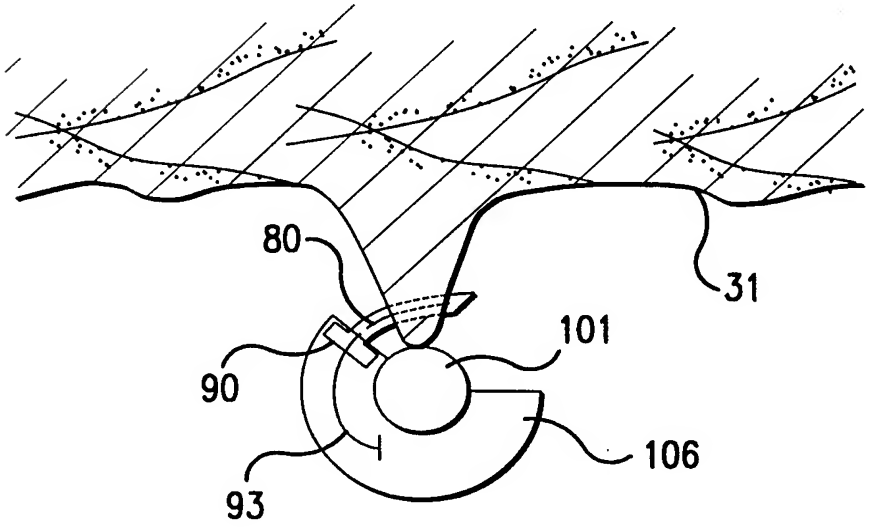

FIG.11B

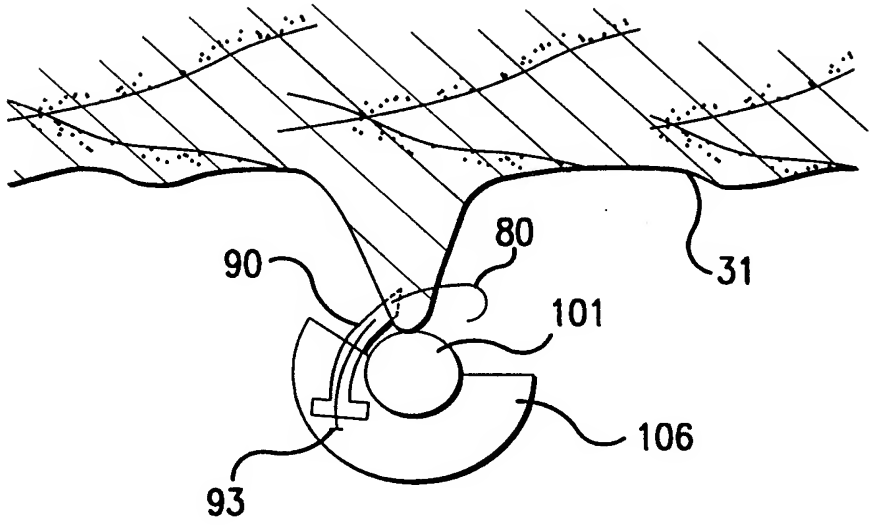

FIG.11C

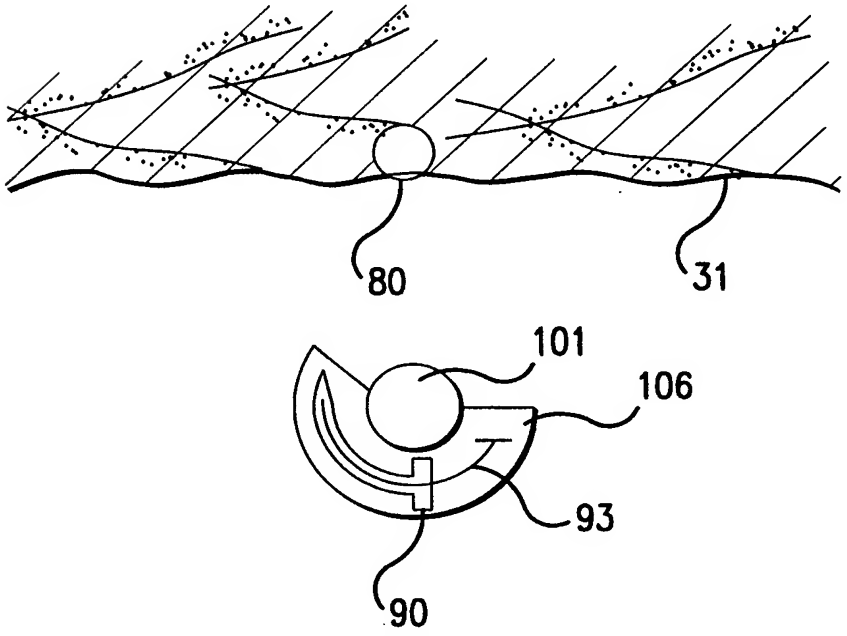

FIG.11D

INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/US 98/12552

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61B17/122 A61B17/128

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 5 002 563 A (PYKA) 26 March 1991 cited in the application see claims 1,4,5	1,2,5,6, 21 3,4,22 25
X	US 4 665 906 A (JERVIS) 19 May 1987 cited in the application see claims 3,12	1,21
X	US 5 632 746 A (MIDDLEMAN) 27 May 1997 see abstract; figures 2-12A,2-12B see figures 2-14	1,2,5,6, 21,26
Y	US 4 485 816 A (KRUMME) 4 December 1984 cited in the application see figures 1,3,4	3,4,22

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 October 1998	12.10.98

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Barton, S

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter. ial Application No
PCT/US 98/12552

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 97 18762 A (INNOVASIVE) 29 May 1997 see figures 7,10,26,39-42	22,23,25
A	US 4 696 300 A (ANDERSON) 29 September 1987 see figure 7	22,23
A	US 4 586 502 A (BEDI) 6 May 1986 see figure 2B	25
A	US 5 258 008 A (WILK) 2 November 1993 see abstract; claim 8	22,25,27
P,X	EP 0 826 340 A (MEDINOV) 4 March 1998 see abstract; figures 3,6-9	1-4,21, 22

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 98/12552

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 7-20
because they relate to subject matter not required to be searched by this Authority, namely:

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [X] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-4,21-24

   u-shaped pseudoelastic clip and system adapted to its delivery

2. Claims: 1,5,6,21,25

   circular pseudoelastic clip and system adapted to its delivery

3. Claims: 21,26,27

   system for placing an array of pseudoelastic clips

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter. ial Application No
PCT/US 98/12552

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter. ial Application No
PCT/US 98/12552

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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